Suggestions to Implement Integrated Solid Waste Management Plan in Galle Municipal Council Area

G.P.R. Abhayawardana [1], W.K.C.N.Dayanthi[1], S.Hapilan[1], A.Kuhathasan[1], S.V.A.D.R.R.Perera[1]
[1] Department of Civil and Environmental Engineering
Faculty of Engineering, University of Ruhuna
Hapugala
Galle
SRI LANKA
E-mail:pavithra.ab@gmail.com

***Abstract**: The present practice of solid waste management (SWM) in the Galle Municipal Council (GMC) area is not adequate to meet the 18 tons of daily SW generation. Hence the suitability of implementing Integrated Solid Waste Management (ISWM) was studied by characterizing SW of the area and studying carefully the current practice. The study revealed that SW was mostly organic with a percentage ranging from 49 to 94 with relatively high moisture content. There was a notable decrease of organic content and an increase of the inorganic content in comparison to previous years. Though the highest calorific value (CV) which was 18 MJ/kg is less than that of normal fuels, fuel generation can be implemented through the production process of Refuse Derived Fuel (RDF). The key suggestions are source separation, introduction of composting and anaerobic digestion for all the biodegradable waste, introduction of recycling options for recyclables and an engineered landfill for the inert matter.*

Keywords: *Solid waste, biodegradable, non-biodegradable, composting, integrated solid waste management*

1. INTRODUCTION

Galle is the main city in the Southern Province of Sri Lanka with a population of 125,000 spreading in an area of 16 km^2. GMC has carried out the SWM of this area since more than a hundred years ago. Though there were all elements of SWM like collection, transport, treatment and disposal, it was evident that the existing system is not satisfactory. The municipality area is divided into 14 wards in which the generated waste is daily collected. The organic waste from 3 wards is used to produce compost and another small portion is used at the anaerobic digester at the GMC premises. The rest is dumped at a semi-controlled landfill at Heenpanthala. The energy from the anaerobic digester is used for some activities in the GMC and the produced compost is used at a farm and the rest is sold to the public. The compost is of low quality due to not maintaining the optimum conditions (moisture content, particle size) during the process and not using modern machineries like huller machines and cutters. Source separation is hardly practised and unsorted waste is dumped on a semi-controlled landfill with no engineering principles. The disposal site is adjacent to Ging River making the location highly unsuitable due to the threat of contamination of river water with highly polluted leachate.Therefore this study is significant because it is timely and crucial to implement ISWM in the GMC area. The quality, quantity and characteristics of SW are imperative for a sound SWM system that includes the selection of resources and energy recovery potentials. Through a thorough analysis of the quality and characteristics of SW in the GMC area, a proper solid waste practise can be implemented. The aim of this study was to investigate how to implement ISWM plan in the GMC area through an analysis of quality and characteristics of municipal solid waste (MSW).

2. METHODOLOGY

The study area (Figure 1) consisted of fourteen wards of the GMC, namely Fort, Bazaar, China Garden, Pettigalawatta, Magalle, Katugoda, Eliot Road, Kaluwella, Richmond Hill, Hirimbura, Ginthota, Kanampitiya, Market and Thalapitiya. The study was based on three main aspects which are waste characterization of the GMC area, the existing SWM practice and the public awareness and involvement.

For characterization of the SW, the waste collected from all fourteen wards were subjected to the following analyses: SW composition, bulk density, percentage moisture and total solids content, percentage volatile solids content and the energy content. Composition and bulk density was obtained by manually separating the waste in to categories and weighing and by filling a container of known volume with waste and weighing respectively. Percentage moisture content was calculated by weighing a portion of SW before and after keeping in an oven at 50^0C for 24 hours. Percentage of volatile solids was obtained by igniting the SW in a muffle furnace at 550^0C for 1 hour. Energy content was found by using Bomb Calorimeter test.

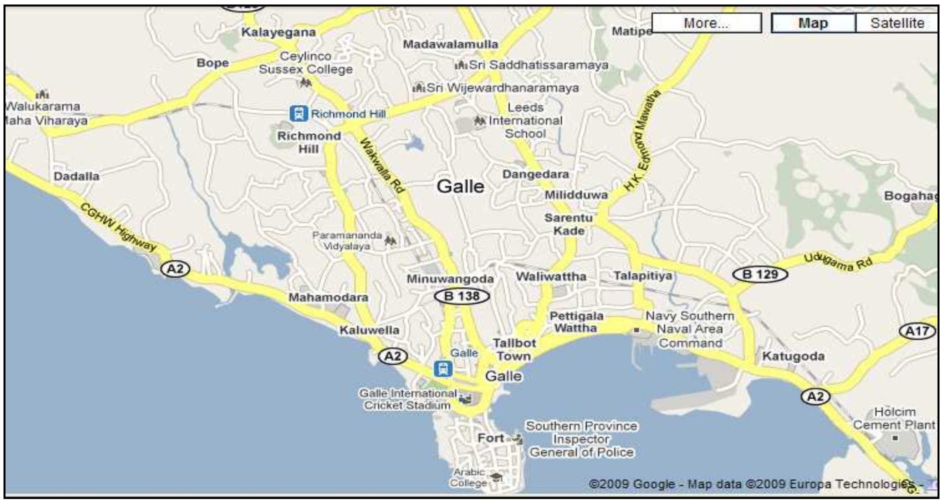

Figure 1 Study area

The study on the existing SWM practice was mainly focused on the composting and anaerobic digestion processes. In order to evaluate the performance of the composting plant, samples were collected from composting piles to represent each week of total 8-week composting period. They were analysed for the percentage moisture and volatile solids content.

In order to evaluate the public awareness on SWM issues and their involvement in related activities, a questionnaire was distributed among 100 households selected randomly covering all fourteen wards. The questionnaire included questions to determine their satisfaction or dissatisfaction over the existing practice of SWM, their views on weaknesses of the current practice and their suggestions to improve it.

In addition another questionnaire was distributed among 25 workers in the SWM sector of the GMC with the intention of collecting data on their capability, safety and requirements. Based on the output, their level of training, job satisfaction, awareness on safety and sanitation were understood.

Finally based on the results of the above mentioned categories, key components of an ISWM plan for GMC were suggested.

3. RESULTS AND DISCUSSION

3.1 Composition of Solid Waste

Figure 2 shows the composition of SW in each ward. It can be seen that the SW from all wards contains a very high organic content. The wards contain an average of 79%, 8% and 9% of polyethene, plastic and paper respectively. Due to the high organic content, the best treatment for this type of SW would be composting. SW from Dewata, Thalapitiya and Hirimbura have the highest percentage of organic content, 94%, 85% and 84% respectively. Therefore SW from these three wards would give the maximum outputs in composting.

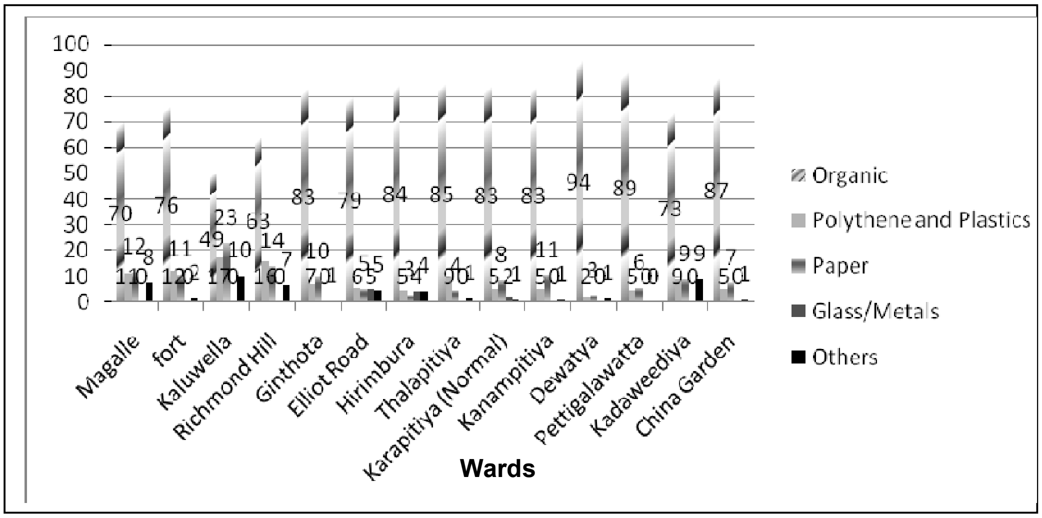

Figure 2 Composition of solid waste

Figure 3 shows the variation of the average composition of SW with time. Comparing with the values of the year 2006 (Karunasiri, 2006) and the year 2005 (Todd, 2005), there is a clear decrease of organic fraction. The developmental activities and the changes in lifestyles of people can be reasons for the reduction of organic content by 7 % in three consecutive years. On contrary the amount of polythene, plastic and paper have increased in a significant amount. It may be due to the extensive utilization of plastic and polythene. Modern technological advances in packaging goods create a constantly changing set of parameters for the designer of SW facilities. Of particular significance are the increasing use of plastics and the use of frozen foods, which reduce the quantity of food wastes at home but increase the quantities at agricultural processing plants (Tchobanoglous et.al., 1993).

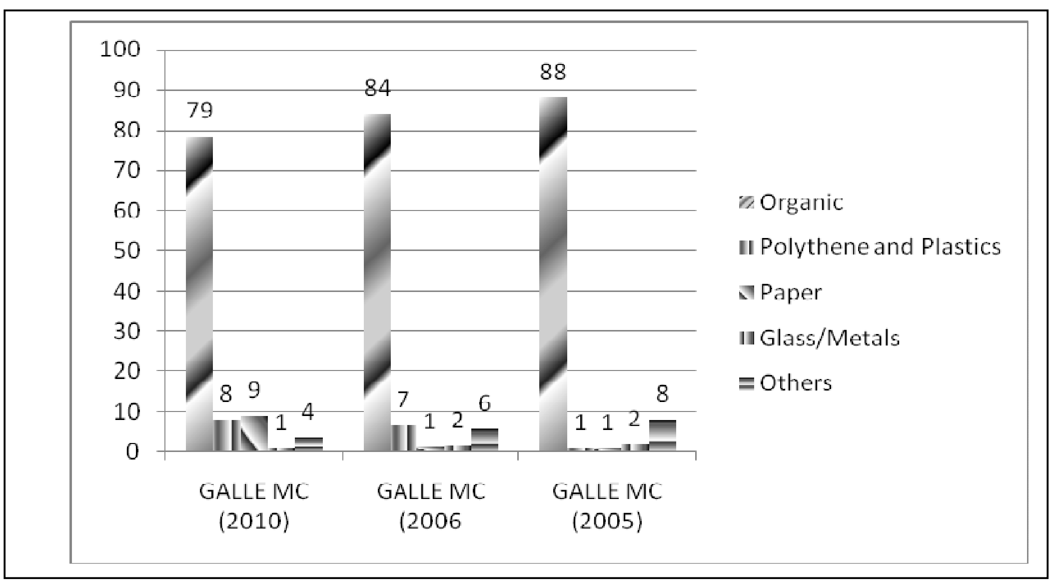

Figure 3 Variation of the average composition of GMC-SW with time

3.2. Moisture Content of Solid Waste

All the wards excluding Kaluwella, Ginthota and Elliot Road contain more than 50% of moisture which can be clearly seen in Figure 4. In many wards the moisture content is more than the solids content. Thus it is very impractical to use methods like incineration to treat the waste. The disposal of waste with no treatment can be highly harmful to the environment as the leachate generation will be high due to the high moisture content.

Landfill- leachate contains a variety of chemical constituents derived from the solubilization of the materials deposited in the landfill and from the products of the chemical and biochemical reactions occurring within the landfill (Tchobanoglous et.al., 1993). Hence many adverse effects can occur due to the mixing of leachate with the water bodies and soil. As the location of GMC- landfill is on a river bank, the adverse effects could be very much high.

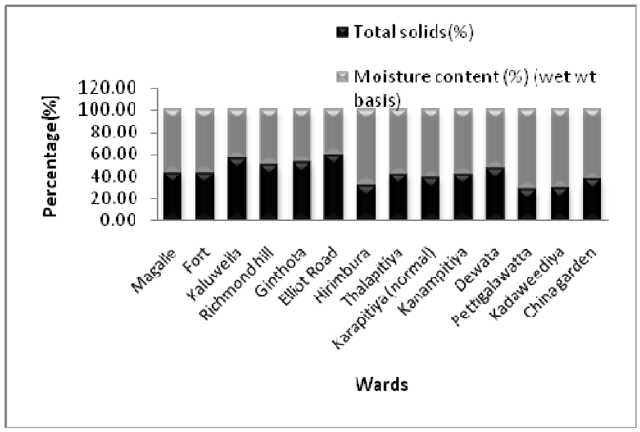

Figure 4 Total solids and the moisture content of solid waste

3.3. Fuel Value of Solid Waste

When comparing the calorific values of SW (Figure 5) produced in the GMC area with those of some fuels, it can be seen that the GMC-SW has very low values. Incineration will not be a suitable treatment technique due to the high organic and moisture contents. If the waste contained high amounts of paper, polythene and plastic, high calorific values could be expected.

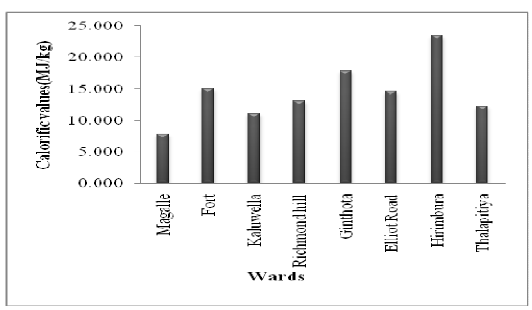

Figure 5 Calorific Values

3.4. Questionnaire Survey among General Public and Workers

According to the results obtained from the questionnaire survey done in 100 households, the public are aware of the SWM practice in GMC area. They appreciate the daily collection. Nearly 100% of the public give their cooperation by placing the garbage bins outside at the correct time for collection by the GMC workers. Some households do source separation of SW as biodegradable and non-biodegradable wastes. Separate containers have been provided to them by the GMC. About 37% from the surveyed community dispose separated waste. However it can also be stated that the public awareness on waste transformation and waste disposal is very less. Less than 10% is interested in home based composting. Thus it can be stated that the public awareness on waste collection is satisfactory, while the awareness on transformation, disposal have to be improved. By the survey done among the workers of the landfill site, composting plant and collection scheme, it can be said that workers are enthusiastic about their profession even under limited facilities. 86% of the laborers satisfy with their job and 86% have received training on SWM prior to work. However their concern on safety is very less. Only 21% use boots; 28% use gloves and none uses masks. Among the problems they face is not receiving vaccination at regular intervals and not being provided with sanitary facilities. They require proper uniforms and rain coats suitable to their work type and the climate. By providing those will increase their efficiency and enthusiasm about the job.

3.5. Present Practice of Solid Waste Management in GMC Area

Only the wastes from 3 wards are currently used for producing compost. Figure 6 shows the variation of the percent moisture content of the composting pile with time. The optimum moisture content for composting is 55 % or at least between 50-60 %. For most organic wastes, once the moisture content is brought to a suitable level (50-60%), the microbial metabolism speeds up (*Tchobanoglous et.al., 1993*). Hence the optimum moisture content is not maintained even in the initial piles. The lack of water added to the piles can be identified as the cause for this problem. Because the water to the site is given by the National Water Supply and Drainage Board, the officers are reluctant to use a large amount of water for the composting piles.

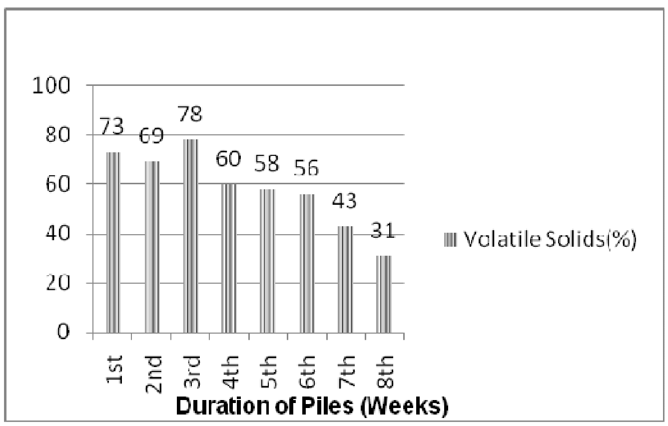

Figure 6 Variation of percent moisture content of the composting pile with time

Figure 7 shows the reduction of the volatile solids content with time. This indicates the efficiency of the plant. The overall reduction of volatile solids during composting is about 40 %. The composting piles showed signs of lack of moisture. The piles of the latter weeks had white fungus such as Aspergillus fermigatus,which is a threat for the human health. This fungus is believed to be responsible for causing respiratory problems if inhaled. Most fungi have the ability to grow under low moisture conditions, which do not favour the growth of bacteria (*Tchobanoglous et.al., 1993*). The compost produced in the Heenpanthala plant is not efficient as a soil conditioner, and there is also no clear characterization of the compost. This can be due to not maintaining the optimum conditions of temperature, moisture content and pH.

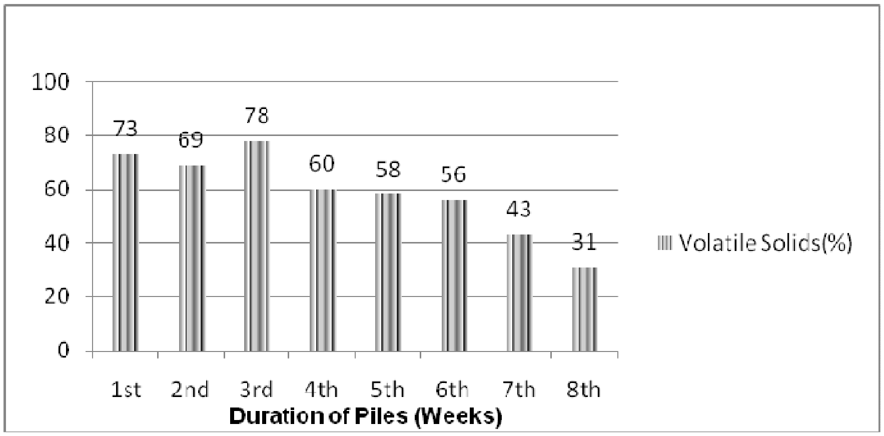

Figure 7 Variation of percent volatile solid content of the composting pile with time

3.6. Suggestions for Implementing ISWM in GMC Area

The key suggestions are based on the following functional elements of ISWM: waste handling and separation, storage and processing at the source; collection; separation, processing and transformation of SW; transportation; and disposal. Source separation of SW is of major concern. The SW collectd from GMC would be categorized into organic waste, reusable or recyclable waste and unusable items and different bins would be provided to dispose those. A suitable colour code can be introduced for easy identification. Households can be advised to implement home based composting systems for organic waste. Several households can get together and maintain an anaerobic digester for their organic wastes. The gas from digesters can be used for cooking purposes. The compost produced at Heenpanthala compost yard can either be used or sold to outsiders. Reusables and recyclables can be collected by the GMC staff once a week. The waste should be transported to the treatment facilities or disposal sites by covered vehicles, thus the odour and vector attraction would be minimal. The vehicles provided for waste collection and transport by GMC should fit to transport waste with high density and moisture content. The vehicles selected should be more suitable for roads of Sri Lanka and the type of SW generated. Heavy vehicles like the compactor truck used in the present practice create a huge traffic congestion in narrow roads and also not easy to be repaired.

The biodegradable waste form GMC should be sent for either composting or anaerobic digestion. The non-biodegradable waste can again be divided into recyclables and non-recyclables. Recyclables like polyethene, plastic, paper, cardboard can be sent to the relevant recycling centers. The non- recyclables can be dumped on an engineered landfill. As home based composting is a key strategy, the composting plants managed by the GMC may not be very large. Turning of piles, moisture content and C:N ratio should be properly maintained in the Heenpanthala composting plant, thus the best quality compost is produced, which is sold to the public at various outlets around Galle.

The gas from the anaerobic digesters at MC office can be used for energy recovery purposes and the slurry can be sold as a fertilizer to the farms. Recycling shops have to be established so that the people can give their paper, metal, glass for recycling or reusing and earn some money. The remaining waste after all the treatment should be disposed in an engineered landfill. The existing semi-controlled landfill at Heenpanthala should be improved to an engineered landfill by providing a proper liner, landfill gas and leachate collection systems and daily and final soil covers.

The waste produced by the Karapitiya and Mahamodara hospitals of GMC area will be separated as hazardous and non-hazardous waste. The hazardous waste can be incinerated within the hospital premises and the other waste have to be collected by the GMC and directed to the common waste treatment stream. The ash or residue from the incineration should be disposed in a separate area.

Another option for this type of SW would be to utilize it in energy generation by converting it to RDF. Though the initial cost of such a facility would be high, it would be possible to implement that technology to all type of SW without going for separate methods such as composting, anaerobic digestion and land filling. Thus it would be advantageous when the long term benefits are taken into consideration. However, the typical moisture content of RDF is 7-28 %(Gendebien et.al. 2000), thus a drying procedure will have to be done for the SW prior to the generation of RDF. By utilizing this technology, the energy problem will be solved by some fraction and the large areas required for land filling and the large number of workers needed for every stage of SWM will be reduced.

4. CONCLUSIONS

Rapid urbanization and industrialization have increased the generation of SW and changed the conventional SW composition in the Galle municipality. Therefore it is timely strategy to develop an ISWM plan for the GMC area.

The results of the SW characterization in the GMC area indicate that the waste is mostly organic and contains high moisture contents. Therefore the treatment methods used by the GMC such as composting and anaerobic digestion are suitable. The waste cannot be directly used for fuel generation. It was observed that the GMC has adopted reasonably good collection, treatment, disposal methods. However the efficiency of those services is not to the satisfactory level. The safety and health condition of the waste handling personals are also not given a proper attention.

The key suggestions to implement an ISWM plan for the GMC are source separation, introduction of composting and anaerobic digestion for all the biodegradable waste, introduction of recycling options for recyclables and an engineered landfill for the inert matter. The production of refused derived fuel is another option to utilize the fuel value of solid waste. It is concluded that if the public support can be obtained through good awareness, and if the current services and facilities are improved, ISWM could be successfully implemented in the GMC area.

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